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BLACK MEASLES, WATER BERRIES, AND RELATED VINE TROUBLES

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BY
FREDERIC T. BIOLETTI

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BLACK MEASLES, WATER BERRIES, AND RELATED VINE TROUBLES

BY

FREDERIC T. BIOLETTI

The vine in California, as in all regions where it is grown extensively, is subject to diseases whose causes have not been exactly determined, and for which, therefore, completely satisfactory remedies are lacking.

Among these troubles are several that appear related in their symptoms and which are therefore probably due to similar causes. They are known by a number of names in California, e.g., Black Measles, Spanish Measles, Black Mildew, Blight, Anaheim Disease, California Disease, Santa Clara Disease, Top Disease and—when first noticed in a locality—the "new" or "mysterious" disease. These diseases seem to be identical with, or closely allied to, similar troubles occurring in southern Europe, especially the *Brunissure,* and also to two other Californian vine troubles, i.e., Water Berries and Grape Shrivel.

Diseases of this nature have been very destructive in various parts of California. Between 1884 and 1893 most of the vineyards of Los Angeles and Orange Counties, estimated at over 20,000 acres, were completely destroyed. Vineyards covering an equally large area were destroyed between 1898 and 1900 in the Santa Clara Valley. In addition to the vines destroyed in the great epidemics, numerous sporadic cases of destruction occur in most of the vineyard areas every year. The total number of vines destroyed or injured by these diseases in California has probably been equal to the number of those destroyed by Phylloxera.

The great losses occasioned by such diseases seem to justify the publication of any theory which offers a plausible explanation of their cause and of any remedies or preventive measures which offer a reasonable promise of relief from them.

The theory advanced here is based chiefly on observations of the two great epidemics, of sporadic cases occurring in many districts over a period of many years, and on a consideration of the coincident environmental conditions in the various cases. It is, briefly, that these

diseases are entirely or primarily the effect on the vines of an excess of output over income and the resulting condition of starvation or malnutrition.

The remedies offered are those which naturally suggest themselves, if this theory is accepted. They are based on the principle of affording some means of keeping a proper balance between the demands on the vine and its ability to perform, and consist on the one hand, in measures tending toward its invigoration, such as improvements in irrigation, cultivation, soil treatment and the control of known pests and diseases; and, on the other, in measures tending toward apportioning the amount of crop on the individual vine, arm or cane, in accordance with its size, vigor and condition of nourishment. The principal, perhaps the sole, measures that can be used for the latter purpose are various degrees and kinds of pruning which determine the number of fruit buds on which a vine is allowed to expend its energies.

Symptoms and types.—Some of the names used for these diseases are merely synonyms applied to the same group of symptoms, but others represent more or less distinct groups.

The chief symptoms to be observed are various spots, patches, and dead areas on the leaves, with various brown, red, and yellow colorations; spotting, softening, and premature drying of the fruit, with lack of sugar, acid, color, and flavor; dying back of the tips of the shoots; uneven or imperfect ripening of the canes, which are deficient in starch; dark spots and streaks in the wood; short growth and dying of arms, branches, and in the worst cases death of whole vines and whole vineyards.

All of these symptoms do not usually appear in an individual case and various combinations of them may occur. Some of them may also occur in cases which can be traced to other well-known causes. It is for this reason that so many names have been used. It is often difficult to say in an individual case whether the trouble should be called "Measles" or "California Disease" or something else. This difficulty occurs especially in mild or incipient cases. Even Mr. Newton B. Pierce, who had studied the disease longer than any other investigator, would seldom diagnose a case as one of California Disease until it had progressed almost to an obviously fatal stage.

The various cases, however, may be divided into a few types representing groups of apparently related individual instances.

Type I. California (or Anaheim) Vine Disease and Santa Clara Disease.—This is an epidemic form which has resulted in the destruction of whole vineyards. Two serious attacks of this nature have

occurred in southern California—one in 1885–1886 and one in 1890–1892. These epidemics destroyed most of the vineyards in the most thickly planted areas of the district. Another even more destructive attack of the same kind occurred in the Santa Clara Valley in 1897–1899.

Type II. Black Measles, Spanish Measles, Black Mildew.—These names are simply local variations in nomenclature for the same group or groups of symptoms. This type is distinguished from the first simply by the distribution of the affected vines and by the milder form in which it generally occurs. It is usually confined to certain parts of a vineyard and to certain vines or even to parts of a single vine. Its distribution is sporadic, but it occurs in nearly all districts of low rainfall, whether irrigation is practiced in the locality or not.

Type III. Water Berries and Grape-shrivel.—These names indicate variations of the same type. The first occurs most commonly in irrigated districts, and the second in districts which depend entirely on rain for their water supply. They both differ from the other two types in that their symptoms are confined almost entirely to the fruit, which is soft, watery, and tasteless, and in Grape-shrivel finally dries up without maturing.

The various types seem to be stages of the same disease, or different degrees of malnutrition in the vine.

In Water Berries the vine has been overtaxed only enough to prevent the proper nourishment and complete development of the fruit. The only symptoms present are lack of quality in the fruit and short growth and immaturity of the wood. It is a common thing to see these symptoms on single spurs or branches of a vine which otherwise appear perfectly healthy.

In Black Measles and in the California Disease any or all of the symptoms listed may occur. These types are distinguished from each other only by their distribution, the former being scattered and sporadic, the latter unsparing and epidemic. They appear to represent a chronic state of the same conditions which cause Water Berries. Over-bearing for one year produces Water Berries. Over-bearing for two years or more produces Black Measles or California Disease.

Relation of Crop and Water Supply.—When the incidence of these diseases is compared with the coinciding variations in rainfall and in crop, it appears that a close connection exists between the three factors.

It is generally recognized by local observers that a mean annual rainfall of 16 inches is the minimum that may be expected, in unirrigated vineyards, to give a full crop. In districts where the mean annual rainfall is less than this, and during periods of light rains,

the crops are correspondingly diminished. Where the variations are great between different years, the crops vary on the whole with the rainfall. The variations of both crop and rainfall may range from one to four, or more, in such districts. In irrigated vineyards a similar correspondence between the amount of water given to the soil and the amount of crop yielded by the vine is also frequently observed. The correspondence in this case is not quite so clear, owing to the liability of injuring the vine and its crop by over-irrigation or by irrigating at the wrong time.

The crop may also vary almost as much in different vineyards and in different years according to the method of pruning employed, i.e., according to the amount of fruiting wood left on the vine.

If it can be shown, therefore, that the diseases under discussion occur principally when the amount of water which the soil receives is low and when the crop is large, a plausible explanation for them has been found and a method of protection against them indicated.

The California Disease.[1]—The relation of crop and rainfall to diseases of type I was first pointed out by Bioletti and Twight in 1901 in a report on the dying of vines in the Santa Clara Valley during the years 1898–1899 and 1899–1900. In this report, after enumerating several contributory or predisposing conditions, such as gravelly soil, large pruning wounds, old age of the vines and spring frosts, the principal or general cause of the destruction is given as ". . . the combined effects of the heavy crops of 1896 and 1897 and the four years of drought which followed."

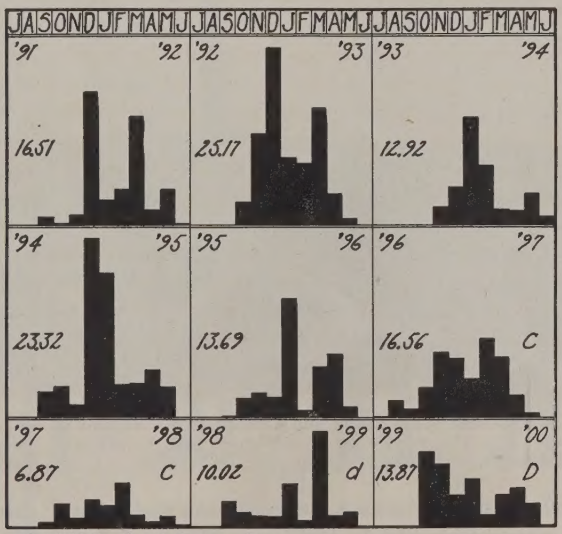
This conclusion was reached after a comparison of the crops with the *annual* rainfall computed from January 1 to December 31. The evidence is even stronger if the comparison is made with the *seasonal* rainfall computed from the first of July to the end of June of the following year. The seasonal rainfall is shown graphically in chart 1.

The seasonal rainfalls from the autumn of 1891 to the spring of 1895 were large, averaging 19.48 inches, or 128 per cent of the normal of 15.23 inches. This condition tended to promote the production of good crops, while as the rains were regular as well as abundant the vines remained vigorous and healthy. During the seasons of 1895–1896 and 1896–1897 the rainfalls were very close to normal and in the latter season the crop was extremely large. The result undoubtedly was that in the spring of 1897 many vines were more or less weakened by over-bearing.

[1] Descriptions of this type of the disease have been published by Newton B. Pierce in "The California Vine Disease," Bulletin 2, Division of Vegetable Pathology, U. S. D. A., 1892, and by Bioletti and Twight in "Report on Conditions of Vineyards in Portions of the Santa Clara Valley," Bulletin 134, Agr. Exp. Station, University of California, 1901.

Probably no serious results would have ensued if the season of 1897–1898 had been one of abundant rainfall, or if the crop had been curtailed by shorter pruning or by other means. Unfortunately none of these protective conditions ensued. The growers, encouraged by the profits of the large crop of 1896, pruned their vines for a still larger crop in 1897, and, the season being favorable for heavy bearing, the crop of this year was extraordinarily large. The seasonal rainfall, however, was extraordinarily small, being only 6.87 inches or 45 per cent of the normal amount.

CHART 1



SANTA CLARA--RAINFALL (MEAN ANNUAL=15.23)

C=HEAVY CROPS--d=DISEASE NOTICED--D=DISEASE INTENSE

The consequence was that at the end of the season of 1897 the vines were still weaker than before, and unprovided with reserve food materials in their trunks and roots. As this condition is not readily perceived nor understood by the growers, few, if any, took precautions to protect their vines. The pruning done was in all probability similar to that of the previous year which had given such profitable results in crop. Irrigation was little practiced at that time in the Santa Clara Valley, and practically none of the vineyards received any water from that source.

The net result was that the crops of 1898 fell to about one-quarter of what they had been the previous year and many vines showed clear evidence of being in a diseased or dying condition. The following season the rainfall was again deficient being 10.02 inches, or 66 per cent of the normal amount. In the spring of 1899 hundreds of thousands of vines died, and by 1901 there were very few healthy or living vines in the Santa Clara Valley. The few that remained were of varieties which seldom produce heavy crops (see fig. 1), or were growing in soils and situations which do not promote excessive bearing or which receive more than the average rainfall of the district.

Fig. 1.—Trousseau vines living and healthy in a vineyard of Mataro which are all dead. The Trousseau were pruned short like the Mataro. They produce little or nothing when pruned in this way.

In 1904 Ravaz[2] presented evidence that the cause of *Brunissure* was over-production, and in 1906[3] gave the same explanation of the dying of vines in Algeria, a case which he considered of the same nature as the Anaheim and Santa Clara cases in California.

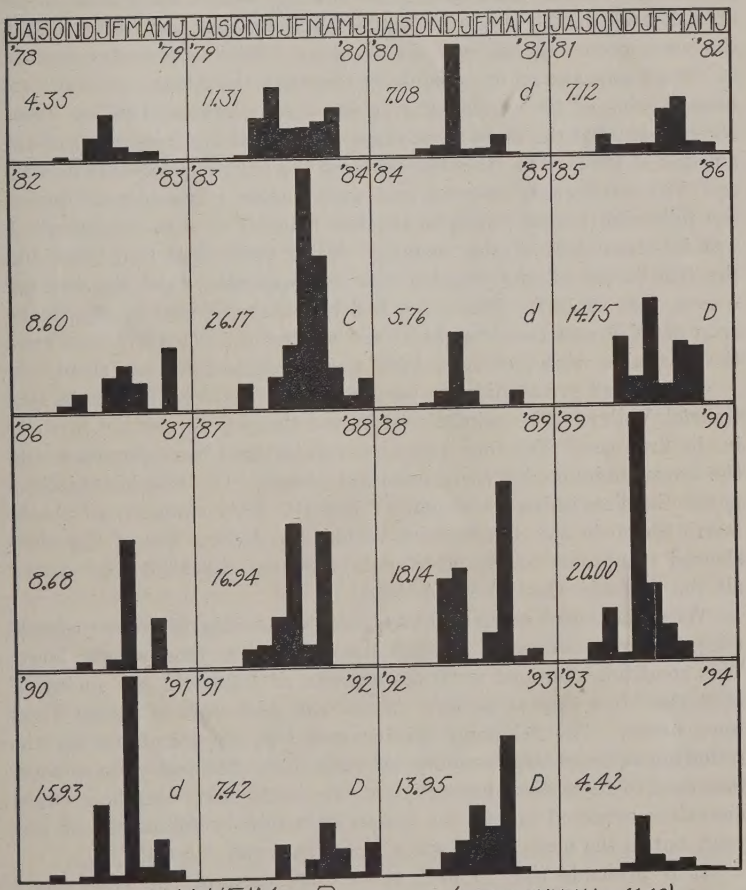
Strong evidence in support of this view is obtained by a study of the rainfall in southern California in connection with published accounts of the crops during the period when the greatest destruction of vines occurred near Anaheim and in the neighboring districts.

Chart 2 shows the seasonal rainfall at Anaheim from July 1, 1878 to June 30, 1894. During this period the two most destructive epidemics occurred in southern California.

[2] L. Ravaz. "La Brunissure de la Vigne." Montpellier, 1904.

[3] L. Ravaz. "Influence de la Surproduction sur la Végétation de la Vigne." Montpellier, 1906.

CHART 2



ANAHEIM -- RAINFALL (MEAN ANNUAL = 11.60)

C = HEAVY CROPS -- d = DISEASE NOTICED -- D = DISEASE INTENSE

In 1884 the crops of grapes were noted as being extraordinarily large[4] in the Anaheim district. The rainfall of the preceding winter had been equally extraordinary, being 26.17 inches or 226 per cent of the normal. The next winter the rainfall was only 5.76 or 50 per cent of the normal, and during the ensuing season many complaints of sick and weak vines were made. The greatest mortality among the vines occurred, however, in the year following this dry winter.

What appears to have happened is that the abundant and prolonged rains of the winter and spring from October, 1883 to June, 1884 stimulated the vines to produce the excessively large crop of the autumn of 1884. The vines thus entered the winter of 1884–1885 weak and with inadequate reserves and were unable to recuperate during the following season owing to the low rainfall of that winter which was less than half of the normal. Many vines died that year, but the full extent of the disaster was not apparent until the ensuing season, that of 1886. The vines had been so weakened by the heavy crop of 1884 and the drought of the winter of 1884–1885, that even the favorable winter of 1885–1886 was insufficient to save them.

The second great epidemic occurred from 1891 to 1893 in the San Gabriel Valley. The rainfall conditions there were similar to those in the first case. For four years the rainfall had been abundant and the crops undoubtedly correspondingly large. In 1883 M. Grosjean noted the flourishing condition of the 800 acre vineyard of A. de Barth Shorb in the San Gabriel Valley. In 1890 a few of the vines showed symptoms of the California Disease. In 1893 Gos[5] found all the vines in this vineyard dead.

What happened seems to have been that during the four years of adequate and increasing rainfall the crops were increasingly large. This condition obtained until the autumn of 1890. In the spring of 1891 the vines appear to have been weak and cases of dying vines were noted. The following winter was very dry, and during the following summer large numbers of vines died. The rest were so weak that most of them died the next year. As in the first case, the greatest mortality occurred not in the season immediately following the dry year, but in the next, which was a year of normal rainfall.

It is probable that in both these cases most of the vines could have been saved if bearing or the attempt to bear had been prevented or curtailed during the year following the unusually large crop. The growers, however, were misled by the belief of Pierce that the disease was necessarily fatal. Some of them neglected their vineyards and

[4] N. Pierce. "The California Vine Disease." Bulletin 2, Div. of Veg. Pathology, U. S. D. A., 1892.

[5] F. Gos. "La maladie de Californie." Revue de Vit. T. 1, p. 14.

others attempted to obtain as large crops as possible while the vines lasted.

In these three great epidemics, therefore, we find similar conditions: (1) a series of years of abundant rainfall; (2) a year of very low rainfall immediately following this series of years: (3) very heavy crops immediately preceding the year of drought and rapid dying of the vines in the year immediately following the drought.

The first epidemic at Anaheim differs from the others in that there was only one year of heavy rainfall immediately preceding the year of drought. Most of the vines, however, were probably young, having been planted during the great planting boom of 1879 to 1881, when the vineyard area of California increased 200 per cent. While the rainfall was low during the seasons of 1880–1881,[6] 1881–1882 and 1882-1883, it was sufficient for the young non-bearing vines so that they were undoubtedly vigorous and healthy when the abundant rains of 1883–1884 enabled them to produce the large crop of 1884.

The evidence, then, is strong that the epidemic form of the trouble is due to excessively heavy crops following good growing conditions and abundant rains and followed or accompanied by deficient rainfall.

The scarcity of the rainfall is probably not so much to blame as its irregularity. Vineyards thirty years old are found growing and in good health where the annual rainfall is less than 8 inches, but such vineyards produce small crops. The trouble comes when peculiarly favorable conditions arise such as to stimulate the vine to extraordinary efforts, which result in a state of enfeeblement from which the less favorable conditions which follow prevent recovery. In other words, the vine dies from a combination of over-load and under-support. Or perhaps a better description would be to say a load too great in proportion to the support.

If this explanation is correct, the obvious remedy for the disease is to diminish the load or increase the support before the vine is too much weakened to recover. The load can be diminished to any desired extent by short pruning and the support can be increased by improving the water and soil conditions.

[6] There were, of course, old vines growing at this time and some of them seem to have shown signs of Black Measles. (See Pierce, *loc. cit.*, p. 62.) That there was no epidemic at that time seems to have been due to the absence of the abundant rainfall necessary for the heavy bearing previous to the dry years. A low rainfall is not shown in the records published by Pierce, who gives the rainfall for 1880 at Anaheim as 22.23 inches, which is nearly twice the normal amount. (See Pierce loc. cit., p. 112.) This condition would be likely to produce a heavy crop, and as 1881 was an exceptionally dry season, an attack of the California Disease might have been expected. The rainfall for 1880, however, according to the records of the Weather Bureau, was 12.02 inches, which was insufficient to make up for the deficient rainfall, 8.18 inches, of the previous year.

Fig. 2.—Malaga grapes showing the spotting and drying of the berries, characteristic of Black Measles.

Black Measles.—(See fig. 2.) The theory that the sporadic form of the trouble is due to the same cause as the epidemic form is based more on analogy and similarity of symptoms than on direct evidence.

It seems reasonable to suppose, however, that if a crop much out of proportion to the available water supply will destroy a whole vineyard, it would also destroy single vines having heavy crops in a vineyard where the crops of different vines varied, or even single arms of a vine which bore more than their proper proportion of the crop.

If the disparity between crop and water supply is not great enough to destroy the whole vineyard, it may be sufficient to destroy or seriously injure the heaviest bearing or the weakest vines.

This appears to be what occurs in the regions where Black Measles is found. These are most commonly the irrigated districts and the vineyards most affected are growing in fertile soil.

Variations of soil in different parts of a vineyard are very common and are marked in many parts of the San Joaquin and Sacramento Valleys. Variations of water contents in the soil, due to irregularities of irrigation, are also common. Irregular or ill-judged pruning will likewise introduce injurious variations in the crop of different vines or parts of a vine. All the conditions for local attacks of the Anaheim Disease may, therefore, be present in parts of a single vineyard.

During the seasons 1920–1921 and 1921–1922 reports of sick and dying vines showing the symptoms of Black Measles were particularly numerous. Many reports of this kind were received from the upper part of the Santa Clara Valley where irrigation of vineyards is little practised. A consideration of the water conditions from 1913 to 1922, as shown by chart 3, and of the market conditions during the latter part of this period may furnish a plausible explanation for this situation.

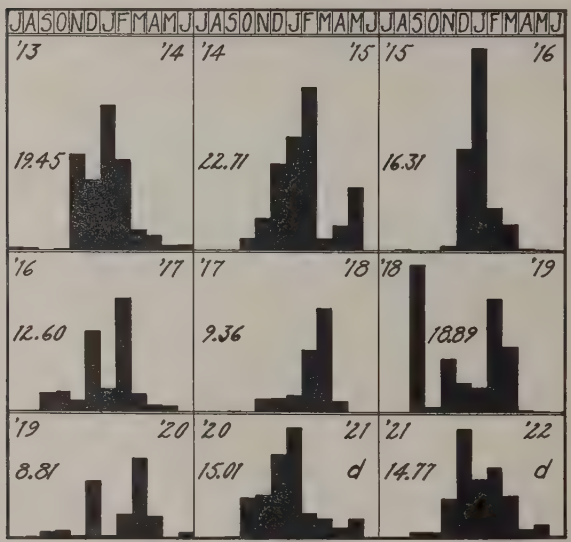
The rainfall from 1913 to 1918 was just a little above normal and fairly regular. In the season of 1918–1919 the rainfall was abundant, being 124 per cent of the normal. The unusually high prices received for wine grapes since that time undoubtedly induced the growers to try to obtain extra large crops from their vines by longer pruning and in this attempt they have been seconded by the favorable rainfalls of 1913–1918 and the abundant rains of 1918–1919. The vines, therefore, had already been taxed to the utmost and the dry season of 1919–1920, which had only 57 per cent of the normal rainfall, increased the strain put upon them.

The conditions have not been sufficiently strenuous to bring about a disaster like that of 1899–1900, but the many cases of Black Measles reported in 1920–1922 indicate a probability that a dry

season during the winter of 1922–1923 might have disastrous results for the vineyards unless by extra short pruning the vines were given a chance to recuperate.

Water Berries.—The term "water berry" as it is usually applied means a grape which is "watery," i.e., lacking in sugar, color, and flavor and of poor shipping quality.

CHART 3



SANTA CLARA RAINFALL (MEAN ANNUAL=15.23)
d= DISEASE NOTICED

The failure to develop properly the sugar, acid, flavor and texture which should characterize a well-nourished mature grape is an unfailing consequence of over-bearing. It may occur on any vine or any part of a vine, however vigorous it may be. It is more likely to occur on vines or canes of moderate vigor.

The grapes on an overloaded vine, therefore, present the same symptoms as those which occur in the disease of Water Berries, and the cause of these symptoms is probably the same in each case, namely undernourishment.

Fig. 3.—Overproduction and defoliation, a combination of weakening conditions which produces Water Berries and is a forerunner of Black Measles.

Figure 3 shows one of the sets of conditions under which Water Berries are likely to be numerous or even to constitute the whole crop. The vines, which are four-year-old Sultaninas, have set a very large crop.

The size of the crop and that of the canes which have grown during its development indicate that the vines had been extremely vigorous at the commencement of the season and that current growing conditions had been good. Unfortunately, just as the grapes ripened, the vines were almost completely defoliated by red-spider and vine-hoppers.

As soon as the leaves have gone, all constructive work of the plant ceases. If the grapes are not fully matured, they cease to develop and become "water berries." If they are mature, the crop may be marketable as good fruit, but the wood will be lacking in reserves. As long as the fruit is developing, it is the first to draw on the food material produced by the leaves, so that if the crop is very large there is nothing left for the rest of the vine. After the fruit is removed, the food from the leaves is diverted to the buds, canes and body of the vine, which then lay up the stores needed to carry them through the winter and to start them off well the following season. If the leaves have disappeared, no food is available to store away and the vines enter the next season in a condition of semi-starvation.

Relation of the Three Types.—The three types of disease which I have discussed appear to be simply three stages or degrees of the same disease.

Under conditions leading to under-nourishment of the fruit we have *Water Berries.* This under-nourishment is due to an excess of crop over vigor. A very weak vine may show water berries with a small crop; a strong vine does so only with a very large one. On a strong vine there may be over-loading of a single arm or cane even when the total crop of the vine is not excessive. Over-bearing, therefore, does not necessarily mean a large crop, but rather a crop too large for the vigor of the vine, or arm, or cane which bears it.

More intense or prolonged conditions of a similar character lead to under-nourishment of the whole vine and the occurrence of *Black Measles.* The conditions which seem most commonly responsible for this form of the disease are over-bearing for one or two years accompanied by some condition which diminishes the recuperative powers of the plant, such as early loss of leaves by frost or defoliating insects, attacks of black knot, root rot, phylloxera or nematodes, and deficiency of water in the soil.

The Anaheim Disease appears to differ from Black Measles only in the thoroughness with which it attacks practically all the vines in a vineyard or in a district. This fact indicates that it is due to some very general cause, or causes. The evidence points to over-bearing and drought as the two principal coöperating causes in this instance.

This theory does not preclude the idea that there may also be some infective organism or facultative parasite concerned in the process. While the first and predisposing causes of the trouble seem to be, generally speaking, over-bearing and lack of water, there are undoubtedly other coöperating causes of weakness present in many cases, and any weakness of the vine makes it more susceptible to many parasites.

It is quite likely, therefore, that the final stages of the disease and its worst cases may owe their severity to some undetected infective microörganism or facultative parasite to which the vine is susceptible only after being physiologically weakened by under nounrishment.

Prevention and Cure.—If the theory I have advanced is correct, prevention of disease depends on properly adjusting the crop to the condition of health and vigor for each vine and for the parts of the vine.

Any vine the growth of which appears deficient in quantity or defective in quality at the end of the season should be pruned shorter than it was at the previous pruning. The number of buds left on a vine, a fruit cane, or a spur should be in proportion to its size and quality.

Any unusually large crop, especially if it is accompanied by Water Berries should be a warning to the grower that he must be very moderate in his demands on the vine for the following year. This caution is the more necessary when other conditions tending to diminish the vigor of the vine are present. If care is taken regularly the danger of the severer forms of the trouble will be much diminished, if not removed entirely.

Whether a cure can be affected will undoubtedly depend on how far the disease has progressed. Cases of recovery are frequently noted. Vines which show Black Measles one year may be free from it the next. Bischowsky, in a report to the State Commission of Viticulture made during the second epidemic in southern California, noted the recovery of a Mataro vineyard which had shown serious signs of the Anaheim Disease the previous year. Not much attention was given to this report on account of Pierce's theory that recovery of the vines was proof that the mysterious and fatal disease, which

he assumed the Anaheim to be, was not present although the symptoms were identical with those of the more serious malady.

It is an undoubted fact that vines showing Water Berries and Black Measles, if they are still alive and show a growth, even a small one, of mature wood and no extensive dead parts, may often or, I may say, usually be saved by short pruning—down to base-buds in severe cases—and by fertilization and other cultural measures which tend to invigorate the plants.

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343. Cheese Pests and Their Control.
344. Cold Storage as an Aid to the Marketing of Plums.
345. Fertilizer Experiments with Citrus Trees.
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347. The Control of Red Spiders in Deciduous Orchards.
348. Pruning Young Olive Trees.
349. A Study of Sidedraft and Tractor Hitches.
350. Agriculture in Cut-over Redwood Lands.
351. California State Dairy Cow Competition.
352. Further Experiments in Plum Pollination.
353. Bovine Infectious Abortion.
354. Results of Rice Experiments in 1922.
355. The Peach Twig Borer.
357. A Self-mixing Dusting Machine for Applying Dry Insecticides and Fungicides.
358. Black Measles, Water Berries, and Related Vine Troubles.

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82. The Common Ground Squirrel of California.
87. Alfalfa.
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127. House Fumigation.
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144. Oidium or Powdery Mildew of the Vine.
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170. Fertilizing California Soils for the 1918 Crop.
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179. Factors of Importance in Producing Milk of Low Bacterial Count.
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182. Extending the Area of Irrigated Wheat in California for 1918.
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218. Advanced Registry Testing of Dairy Cows.
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225. Propagation of Vines.
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230. Testing Milk, Cream, and Skim Milk for Butterfat.
232. Harvesting and Handling California Cherries for Eastern Shipment.
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234. Winter Injury to Young Walnut Trees during 1921–22.
235. Soil Analysis and Soil and Plant Interrelations.
236. The Common Hawks and Owls of California from the Standpoint of the Rancher.

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237. Directions for the Tanning and Dressing of Furs.
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241. Harvesting and Handling Peaches for Eastern Shipment.
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247. Colonization and Rural Development.
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251. Recommendations Concerning the Common Diseases and Parasites of Poultry in California.
252. Supports for Vines.
253. Vineyard Plans.
254. The Use of Artificial Light to Increase Winter Egg Production.
255. Leguminous Plants as Organic Fertilizer in California Agriculture.
256. The Control of Wild Morning Glory.